Introduction

Wideband reflectance (WBR) is a relatively new method of measuring middle ear function/malfunction. Energy reflected by the ear drum is measured to derive information about middle ear transmission and can potentially provide more detailed information about middle ear status than tympanometry. One of the more common types of middle ear pathology in adults is otosclerosis. Diagnosis is complicated by the fact that clinical indicators are similar to other forms of middle ear pathology. WBR may offer information not available from currently used clinical measures of middle ear function. For example, Feeney and colleagues (2003) reported that different middle ear pathologies resulted in different patterns of reflectance. The authors would like to thank Mimosa Acoustics for providing the instrumentation for the study and Parika Shaha for help with data collection.

Method

Participants
18 participants with otosclerosis and 38 participants with normal hearing and normal middle ear function were tested. WBR data was collected from 38 pre-operative and 19 post-operative otosclerotic ears as well as from 57 ears without middle ear pathology. Measures from 6 otosclerotic ears allowed for a direct comparison of pre- and post-operative middle ear function.

Instrumentation
The audiometers and middle ear analyzers used for data collection were calibrated to American National Standards Institute (ANSI) standards S3.6-1996 and S.19-1987, respectively. Mimosa Acoustics Reflectance Measurement System (RMS4) and Head21 middle ear power analyzer (MEPA3) were used to obtain WBR measurements. Both systems consist of a laptop computer, digital processing (DSP) PC card, Eartune ER-10CP Probe, Probe Interface Cable (PIC), four-cavity calibration device, and the measurement software.

Procedure
All measures were obtained in a sound-treated room. The evaluation consisted of otoscopy, pure-tone audiometry, tympanometry and WBR measures. Some participants were being seen as a part of a medical evaluation to rule out a middle-ear pathology. Others were persons with normal hearing who were tested for the purpose of obtaining normative data. Data collected from the ears identified as having otosclerosis were classified as pre-operative otosclerotic ears. Data collected from the ears identified as having otosclerosis were classified as post-operative otosclerotic ears. Data from ears with normal hearing and no diagnosed middle ear pathology were classified as such.

Before each WBR measurement, RMS4 and MEPA3 were calibrated with the four-cavity device using the procedure recommended by the manufacturer. A total of three WBR measures for each ear were obtained for each participant. After each measure, the probe was removed and reinserted in order to verify test-retest reliability of WBR measurements. Two out of three measures per ear were averaged for further analysis.

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Conclusions

Pre-op
- Considerable inter-participant variability across all WBR measures
- Results corroborate the findings of previous studies: (1) increased reflectance below 1 kHz in (most but not all) otosclerotic ears, (2) further evidence of inter-participant variability
- 10 ears within 10th-90th percentiles, others above 90th percentile
- Resistance: 11 ears below 10th percentile between 500-1000 Hz
- Other measures inter-participant variability, as in reflectance measures (some ears within 10th-90th percentiles, others above 90th percentile)

Post-op
- Post-op measures reflect the combination of changes to the middle ear system introduced by the method utilized to gain access to stapes during stapedotomy surgery, and the piston prosthesis used
- Increase: 4 out of 6 ears show decrease between 500-1000 Hz
- Resistance: 4 out of 6 ears show increase between 750-1250 Hz
- Impedance Magnitude: in 4 out of 6 ears pattern of upward shift occurring at lower frequencies (below 1000 Hz) re: post-op (all ears below 10th percentile)

Air-bone gaps
- Improvement for all participants (except for 1 ear at 1 frequency)
- Individual WBR measures in agreement with ABG (1 exception): decrease in ABG reflected in decrease in reflectance between 500-1000 Hz, little/no change in ABG echoed by little/no change in reflectance

References